

1. Introduction

→ Objectives of this work:

- To adapt a model describing soil heterotrophic respiration, derived from the CENTURY model, to an agricultural soil situated at the Carbo-Europe site of Loncée (Hesbaye region) in Belgium.
- To highlight the main parameters of the model in order to define further steps of investigation and to improve its adjustment on experimental data.
- To get first results of a calibration phase on bare soil.

→ Further goal:

To integrate the present model as a sub routine in a larger soil respiration model which will include a heterotrophic respiration component, an autotrophic component and a soil CO₂ diffusion submodel (Fig. 1).

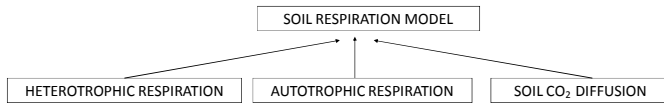


Fig. 1 : Outline of the larger model which will be set up.

→ The present soil heterotrophic respiration model:

- Is derived from the CENTURY model.
- Was simplified and adapted for a daily application by V. Le Dantec at the CESBIO (Toulouse, France).
- Aims at describing processes at an ecosystem scale.
- Uses a mechanistic approach.

→ This soil respiration model:

- Will be applied to agricultural soils at an ecosystem scale.
- Will be as mechanistic as possible and use a daily time step.
- Will be validated on experimental measurements.
- Could be used to compare soil CO₂ production resulting from different crop management methods and different culture types.

2. Model description

→ Inputs

- Daily meteorological inputs from automatic measurements (Temperature, Soil moisture content) in each soil layer
- Residue input frequency : annual sum based on measurements

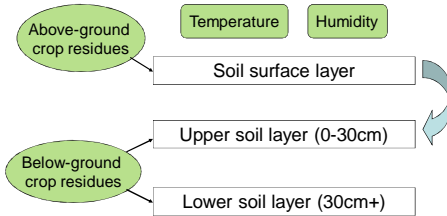


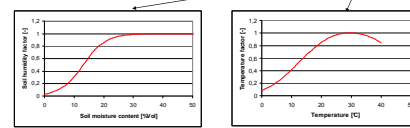
Fig. 2: Inputs (in green) and layers of the soil heterotrophic respiration model

→ Carbon pools

- 3 pools in the soil surface layer (soil surface residues (metabolic/structural C), microbial pool)
- 5 pools in each soil layer (Soil residues (metabolic/structural C), microbial pool and active, slow and passive pools)

→ Carbon flows between pools (F_x):

$$\frac{dC_x}{dt} = F_{x,in} - F_{x,out} \quad F_x = K_x \cdot Q_x \cdot Aw \cdot At \cdot C_x$$



→ Respiration fluxes:

Fractions of F_x, depending on biochemical characteristics of residues and on soil clay content.

- Decomposition constant (K_x)
- Soil texture factor (Q_x)
- Soil humidity factor (Aw)
- Soil temperature factor (At)
- Pool carbon content (C_x)

Temperature and humidity response functions need an adjustment on experimental data

3. Model parameterisation

→ Literature survey for a first approach of model parameterisation:

- Biochemical features of residues (Lignin, Cellulose and Nitrogen contents)
 - For Sugar beet, Winter wheat and Potato crops
 - Large variability of the values
 - Lack of information concerning Sugar beet and Potato crops
- Root distribution in the soil
- Soil characteristics of loamy soils
- Other parameters: e.g. temperature at which the respiratory activity of micro-organisms is maximum

Long term

Parameters	Sensitivity (S) [-]
Tb	0.587
MBR	0.361
Litfall	0.351
h	-0.304
Hu2	-0.064
Lignrl	0.036
Lignroot	0.033
Nroot	-0.031
Nlit	-0.026
Lignlit	0.026
Lignl	0.024
Hu1	0.005
H2O30	0.000

→ Results of the sensitivity analysis:

- Tb, h: Parameters of the temperature response
- MBR, Litfall: Quantities of below-ground and above-ground crop residues respectively
- Hu1, Hu2: Parameters of the humidity response
- H2O30: Water quantity which percolates under 30cm depth

Main points:

- Importance of the parameters linked to temperature and to residue quantity and composition
- Different influences of the parameters between the short and long terms

Short term

Parameters	Sensitivity (S) [-]
Tb	0.134
Litfall	0.104
MBR	0.085
h	-0.069
Hu2	-0.024
Nlit	-0.021
Lignlit	0.021
Nroot	-0.019
Lignroot	0.019
Lignrl	0.019
Lignl	0.017
Hu1	0.005
H2O30	0.000

4. Calibration on experimental data

- Soil respiration measurements were performed from 26/03/2007 until 16/07/2007 (chamber method, automatic system) on a **bare** soil in Loncée (neither vegetation nor residue input in this calibration phase)
- Soil carbon pool contents were set according to soil carbon measurements performed at the Loncée site
- Temperature response parameters were adjusted on experimental data in the three layers of the model
- The humidity response we used was set up and calibrated on 2007 data (Suleau et al., 2008)

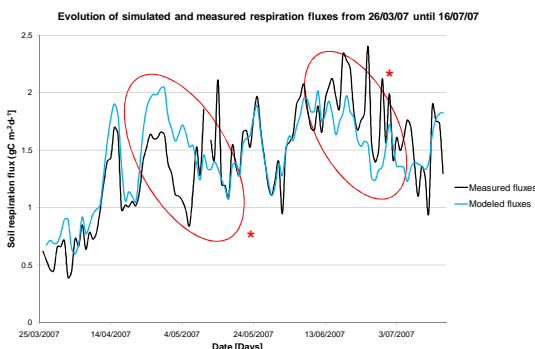


Fig. 3: Evolution of measured and modeled soil respiration fluxes through time. * refers to bad agreement periods between the model and the data.

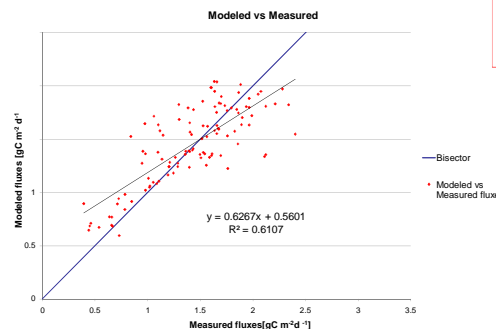


Fig. 4: Comparison between measured and modeled soil respiration fluxes

- There is an overall good agreement between the model and the data (Fig. 3)
- The model tends to overestimate low fluxes and to underestimate high fluxes (Fig. 4)
- For some periods (*, Fig. 3) the model disagrees quite strongly with the data
 - What do these periods correspond to?
 - Is there an influence of carbon pool repartition on respiration fluxes?

5. Prospects

- To set up experiments in order to refine our understanding of the influence of temperature and humidity on soil micro-organisms activity
- To take soil nitrogen dynamics and crop management methods into account
- To go on with model calibration and validation
- To integrate the present model as a subroutine in a larger soil respiration model